Training Issues Associated with the Advanced General Aviation Transportation Experiment (AGATE) and Small Aircraft Transportation System (SATS) Programs

Steven Hampton

Department of Aeronautical Science
Embry-Riddle Aeronautical University

ABSTRACT

The paper provides an overview of the NASA AGATE Flight Training Curriculum -Work Package Six 1998 and 1999 activities. Reports on specific activities include a summary of the results of the 1998 curriculum development and Multi-Function Display (MFD) effort. A discussion of 1999 activities related to the Curriculum, the Primary Flight Display (PFD), and Embedded Training will demonstrate the efforts being undertaken address concerns related to human error and safety associated with automated systems in the General Aviation (GA) cockpit.

.

In addition, a training roadmap developed for the NASA/FAA SATS initiative will be reviewed. An integral element of the potential success/failure of SATS is focused on free-flight concepts, and the use of data-link for information and communication purposes in the GA cockpit. The roadmap addresses those issues.

INTRODUCTION

While in 1990 few new R & D efforts were under development for GA, NASA in 1992 undertook to sponsor that development through a program (AGATE) of coordinated development over a seven-year period beginning in 1994. The programs are currently sponsored through a consortium that includes NASA, FAA, industry and Universities. Members of the consortium split technical costs, 50% government, 50% industry and universities. Membership of the consortium now exceeds 70 member companies and the previously mentioned US government agencies. Many of the major US GA industry companies are members with several taking leadership roles. Within AGATE there are a series of work packages with responsibilities in specific areas.

The AGATE program has identified training as a key component to the success of the series of development efforts being undertaken by NASA to promote research and the development of new technologies within GA. Training is the responsibility of Work Package Six. Work Package members include Embry-Riddle Aeronautical University, The Ohio State University, Jeppesen-Sanderson Co., Advanced Creations Inc., the FAA (Civil Aeromedical Institute and HQ AFS-840), and NASA. The FAA provides government leadership while Embry-Riddle leads the University-Industry Work Package Six Team.

The opportunity afforded the training community to be part of the development process by the manufacturers is a chance to develop systems that are not only well engineered for manufacturing, but also systems which taken into consideration human factor and training issues. While the goal for Work Package Six is to reduce training time and cost, equal attention is paid to human factors and safety issues, especially those surrounding the introduction of a glass cockpit and automation to a GA type aircraft. Work Package Six is currently focusing on the development of an integrated curriculum that seeks to minimize training time and cost through the consolidation of Private and Instrument training using a one-stop approach to Private/Instrument certification. Other activities are focused on the development of "Learning Modules" addressing the training of an AGATE multi-function display (MFD), Pilots Flight Display (PFD), and embedded training systems.

The primary goal of AGATE is to establish guidelines, standards, and certification methods for both the airplane and training/certification processes. Work Package Six is focused on the training and certification process of the pilot.

The implications for training as the new technologies are developed are enormous. Not the least of, which is perhaps the suggestion that use of these technologies will significantly reduce the amount of training, needed to develop the skills necessary to fly. A case in point being that for the AGATE aircraft, the pilot will need to learn only one navigation system to fly the aircraft. Although it is likely that different ground and satellite-based systems may provide the electronic signals, the pilot will see and use only one, much as the commercial operators, those using FMS do today. Critical to the success of the program however, is the need to develop guidelines and standards for the development and operation of these systems to reduce the chaos introduced by the use and training of pilots to use Global Positioning System (GPS) based systems. This does not mean that systems cannot have individuality, but they must have a common core of approved operations that use the same logic and require the same inputs.

AGATE BASELINE

A major goal of the AGATE program is to reduce flight training time to the Instrument / Private level. Work Package Six members are tasked with reducing training time and cost by 25% from the traditional training model. Team members chose to use a proficiency-based model with a maximum use of technology to achieve the given goal. Given that the existing model is based on FAA time requirements, one challenge was the development of a realistic baseline metric from which to measure success or failure.

Baseline metrics developed by Embry-Riddle under contract to NASA in 1994 were used. These metrics were based on the success of students completing the traditional proficiency based training curriculum at Embry-Riddle for a period of three years prior to the study. Using the data, Embry-Riddle was able to establish time requirements for student pilots to reach the Private / Instrument level. The data was checked at the same time by using data from another Part 141 operator. The combined data was then used as a baseline against which to measure the success or failure of the strategy for reducing training for the AGATE pilot.

1998 ACTIVITIES

The first funded year for AGATE Work Package Six was 1998 during which two major activities were funded. The first was the development and testing of a learning module to evaluate the training implications for a GA pilot of a multi-function display called the Integrated Cockpit Information System (ICIS). A second activity developed and validated two proficiency based training curricula including a traditional module consisting of Private Pilot training followed by training for an Instrument rating, and a second, a unified Private/Instrument curriculum where Instrument training was integrated into Private pilot training.

Integrated Cockpit Information System (ICIS)

To address the first activity, the approach taken by the team was to develop a Computer Based Training (CBT) training module to teach subjects how to use the ICIS and as part of the process use a scenario based test approach after training. The CBT was developed by Jeppesen-Sanderson while the human factor issues and experimental design was developed by Florida Institute of Technology (Dr Alan Stokes). Concern was expressed within the group however, as to whether the use of CBT was appropriate. Therefore, the team chose to conduct a three way test to compare the performance of subjects who had received three separate types of treatment. One group of subjects received CBT, a second group received classroom instruction, and a third were asked to read an instruction manual. All three training modules were based on similar information and used similar graphics.

Initial results from the activity suggested that for teaching someone how to use a system like the ICIS that CBT may be an appropriate training method, and that the level of learning is at least equal to that of using the more conventional methods. Training consisted of 45 minutes of instruction followed by a 15-minute scenario based test. At the completion of the test the subjects were all able to accurately and successfully use the system. It should be noted, however, that the ICIS system was developed by Work Package Six with the express purpose of demonstrating that a complex display system, such as the ICIS, if properly designed with consideration of human factors and training issues, could be successfully operated with a minimum of training time using CBT as the training tool.

Specific results show that the performance level of the three training groups were similar, and further, that there were no significant differences between the groups of subjects. Given that the training methods produced similar results it might suggest that the cheapest method (manual) may be the most appropriate. There are however some other considerations that concerned team members.

1. There are no standards established for the development and use of Operators Manuals for avionics.
2. Classroom instruction is too expensive on an individual basis and there is no standardization or training provided by manufacturers.
3. Effective Computer Based Training is very expensive and difficult to develop.
4. A Web Based (Internet) approach, while expensive and time consuming to develop, allows easy and quick updates.

Flight Training Activity

The second activity in 1998 was to develop and test two proficiency-based flight curricula. Jeppesen Sanderson, under Part 141.57 Special Curricula, developed both of the courses. The first curriculum was used to establish "baseline metrics" against which to measure the success or failure of future AGATE integrated curricula. The task was quite difficult in that both curricula still had to meet the existing regulatory requirements and the students had to meet and pass the existing Practical Test Standards.

The first curriculum while proficiency based, followed the traditional model used in the United States of Private Pilot certificate training followed by Instrument rating training. One difference, however, was that both of the FAA Flight Practical Tests were conducted in sequence by an FAA designated examiner at the completion of training.

The second curriculum uses a novel approach in that the Private/Instrument training content is "Unified", or "Integrated". This is a "novel" approach in the civilian world in that only a few curricula have been developed and tried, the last being at the University of Illinois in the 80's. The military however, have used an integrated training approach for some time at Undergraduate Pilot Training.

Both curricula were developed and approved by the FAA Principal Operations Inspector (POI) for Embry-Riddle (Daytona Campus) over a period of two months in the fall of 1997. Training began in the spring of 1998 with the goal of completing 70 volunteer subjects in six months. The subjects were all students at Embry-Riddle. Ten students completed training by the end of August 1998 and those others remaining in the program have since completed. Results from this experiment are being used to help develop the next AGATE curriculum, the "modified Integrated Curriculum" which will be tested in the Fall and spring of 1999/00.

1999 ACTIVITIES

For the second year of the AGATE CDT, four major activities were funded. The first was the development and testing of a learning module to evaluate the training implications for a GA pilot of a PFD with a HITS system. A second activity has been to develop a “modified” proficiency based training curriculum. The third task being to address pilot certification issues. A fourth assignment is the development and investigation the usefulness of an embedded training system for the AGATE aircraft.

Primary Flight Display (PFD)

While all of these tasks are indeed a challenge and are time critical, results to date are exciting. The first task, the development and validation of a PFD with a HITS system learning module has progressed well. Our simulation partner Advanced Creations Inc. has developed a representative system with some assistance from Ohio State University (Dr. Richard Jensen). The system will be on display at the Oshkosh Fly In this summer. Jeppesen-Sanderson is currently developing the CBT that will be used to train and test experienced and inexperienced pilots this fall at Embry-Riddle.

The design for the PFD and HITS is based on previous work completed by ACi, Jensen and CAMI and approved as representative by AGATE’s Flight Systems Work Package who are responsible for the development of the cockpit displays. The system is designed in a modular fashion to allow quick modifications to the software to accommodate changes expected as the Flight Systems work package completes its work. The results generated by this experiment and the previous ICIS experiment will be fed back to Flight Systems to aid them in their development to make smart decisions to accommodate training and make their systems user friendly.

Modified Integrated Curriculum (MIC)

Development of the MIC has been in progress since May 1999, and will be completed in time for use in the fall of 1999 and spring 2000 semesters at the Daytona Beach campus of Embry-Riddle. Another site has also been chosen to test the curriculum to see if similar results can be achieved. While the first curriculum demonstrated that the use of an integrated Private/instrument curriculum is feasible, the true savings of such a training system will not be realized until the modern technologies are introduced into the training cockpit and existing certification regulations are changed to reflect them.

Given that the first years efforts were the first time that successes and/or failures in a flight curriculum were measured, a second follow on curriculum is needed to verify results and demonstrate that similar training could be conducted at a location other than at Embry-Riddle. A second site has been chosen at a Part 141 flight school.

In addition to the use of a proficiency-based training approach for the flight activities, the 1999/2000 curriculum will take advantage of internet and CBT initiatives the team worked on in 1999. Team member Jeppesen has developed CBT for the Instrument pilot ground school and Private pilot maneuvers. In addition, use of the web will allow students to review courseware materials (slide presentations) take pre-tests, and chat / communicate with their instructor from the comfort of their home. This last capability is of significant importance since it will allow for the first time students at off-site locations easy access to, and for the students to interact with and use training materials at a central location. Use of such a system improves standardization and makes it easier to establish a final authority. Future plans call for fully developing the Internet capability, through the use of Internet-based CBT.

Other uses of technology in the MIC will include use of GPS based tracking systems to improve de-briefing of flight activities. The system will use GPS to track and record student progress and afterwards the flight can be reviewed and evaluated by both the student and instructor using a low cost PC-Based system. PC-based Aviation Training Devices (PC-ADTs) will continue to be used to maximize training value for those maneuvers deemed appropriate based on the results from the first unified curriculum which used the devices extensively.

Pilot Certification / Practical Test Standards

How to effectively evaluate the AGATE pilot is a principal concern of the Work Package Six team. Further, how to transition a pilot from current technologies to future technologies and in reverse, is considered to be a major challenge for the following three reasons:

1. Use of the existing PTS for both the Private and Instrument check rides result in an unacceptably long flight (in excess of 3 hours) that has considerable duplicity, and limited practical applicability.
2. Current PTS requirements do not adequately address the use of future technology in the cockpit, and instead focus on traditional maneuvers deemed essential to safe flight.
3. Existing regulatory requirements are time based with minimal hours for students training under both Part 141 and Part 61.
4. The regulatory change process is both slow and cumbersome. A case in point, is the ten-year change process to Part 61 and Part 141.

Team members are addressing the first two issues in 1999 and the first task has been to identify those maneuvers in the existing PTS that can be combined to reduce time on the check-ride. Secondly, team members have been working with the FAA to identify those maneuvers/activities suitable for checking in the AGATE type airplane.

An example of this, is the likelihood of a turbine powered small general aviation aircraft from the NASA sponsored General Aviation Propulsion (GAP) program. Under the existing rules the pilot would have to take and pass a type certificate check-ride in addition to the Private certification and Instrument rating check-rides. Given that the performance of the turbine powered small general aviation aircraft will be similar to that of current piston powered single engine aircraft, and the systems to operate such an aircraft will be simpler, the FAA has moved to consider eliminating the need for a separate type certificate check-ride.

Embedded Training

Work Package Six chose to take advantage of an NASA SBIR award addressing the use of “Low Cost Flight

Training Systems” won by team member ACi., to develop and test the use of an embedded training system using the Simulation Training Testbed (STT) for the AGATE aircraft. Team members developed a experimental design using a maneuver to evaluate whether or not use of an embedded training system benefits the training process. Fiscal restrictions have resulted in this project being delayed for the immediate future.

FUTURE ACTIVITIES

The program will continue to be funded through 2001. Activities will include full integration and testing of the HITS/ICIS cockpit system, certification issues, and continued work on the integrated curriculum. Testing and validation of the “Integrated AGATE Curriculum” and development of the Embedded Training concept will not be complete until after the end of the AGATE curriculum, as part of the NASA/FAA sponsored Small Aircraft Transportation System (SATS).

SMALL AIRCRAFT TRANSPORTATION SYSTEM (SATS)

While development of the enabling technology is critical, also critical is development and implementation of the supporting infrastructure to allow the aircraft to operate to its maximum potential. The following letter from NASA Program Manager Dr. Bruce Holmes defining the SATS program highlights the issues. These are issues that will face the aviation training community into the next century:

“The nation’s 21st century transportation demand cannot be satisfied through the planned national investments in the hub-and-spoke and highway systems. This paper presents trends and forces that shape 21st century demand for higher-speed intermodal transportation, with a focus on an emerging role for personal air transportation. The discussion outlines strategic guidance developed by NASA in partnership with the FAA, state governments, university, and industry partners. This guidance is captured in the National General Aviation Roadmap and includes the goals, objectives and timelines for coordinated Federal, State, and industry investments in technologies and partnerships for creation of a Small Aircraft Transportation System (SATS).

Early 21st Century Transportation Challenges and Opportunities. - Throughout U.S. history, our nation created economic growth, driven by transportation advancements (as well as communication advancements), in major phases. Four hundred years ago, wealth was created at seaports, two hundred years ago at river- and canal-ports, one hundred years ago at railheads, and beginning fifty years ago at interstate highway on/off-ramps. During the 1970’s, the introduction of the nation’s hub-and-spoke system for air travel continued this economic forcing function. Looking forward twenty-five years, beyond saturation of the national highway and skyway systems (gridlock and hublock) the nation faces new challenges in creating transportation/communication-driven economic growth and wealth.

The nation’s 21st century transportation demand cannot be fully satisfied through the planned national investments in the hub-and-spoke and highway systems. Studies of both highway and hub-spoke congestion are confirming the diminishing returns on investments in these systems aimed at managing congestion. One conclusion of such a recent study concluded, for example, “. . .analysis of 15 years of data in 70 metro areas adds to the growing body of evidence that . . . highway construction is an ineffective means of managing congestion. In fact, numerous studies indicate that highway construction often generates more traffic, raising congestion levels. Given the enormous cost of highway construction, our transportation officials need to investigate a broader menu of congestion relief measures that include other transportation modes, new technology, pricing, land use, and other strategies."

Similar conditions are unfolding in the hub-and-spoke system. The expansion potential for both the hub-spoke and highway systems is limited by the physical nature of their system constraints. All innovations operating within constrained systems follow common life cycle behavior, including phases of birth, growth, maturity, and decline. As an innovation approaches the maturity phase in the life cycle, significant growth and innovation is no longer readily achievable within the constrained system. The U.S. currently utilizes about five percent of its landmass for population. If we are to meet the challenge of 21st century transportation demand, we will need many options, including perhaps options that consider alternative land use, beyond of the confines of the current population distribution. One such option would be to improve land use through transportation capabilities enabled by a Small Aircraft Transportation System (SATS).

Several converging forces are fundamentally re-shaping transportation demand characteristics as we move into the first decade of the 21st century, including the following:

1. The maturing of the hub-spoke infrastructure into the saturation phase of its natural growth cycle or "hub-lock" by about 2003;
2. The increasing "gridlock" on the nation's already mature highways;
3. A "third wave" migration of Americans and their jobs from the suburbs to locations further from city centers (the first wave being from farms to cities, the second from cities to suburbs);
4. The peak of the Baby Boomer generation's spending and traveling wave;
5. The transformation of industry from standardized to customized products and services (including transportation in the information age;
6. The soaring value of human time (and therefore the premium value of doorstep-to-destination speed) during the information age.

The convergence of these forces creates a chaotic period for the nation's transportation system. The characteristics of any innovation during its chaotic maturity phase include saturation, dissatisfaction, consolidation, de-personalization, concentration, and economic risk-avoidance. This chaos, in transportation, takes the forms of infrastructure saturation; consumer dissatisfaction; consolidation of manufacturers and service providers to obtain economies of scale; de-personalization of products and services; consolidation of markets; increasing pace of smaller refinements in products and services; fewer (if any) significant innovations; and reduced financial risk tolerance.

From a natural life-cycle viewpoint, periods of chaos and maturity serve to stimulate ensuing significant advancements. The successive emergence of horse-paths, canals, railways, roadways, and hub-spoke airways for intercity travel illustrate these life cycles. Each new mode emerged during the maturity phase of the previous mode. The saturation phase of the current hub-spoke airway system ("hublock"), coupled with highway gridlock creates pressures for change.

One of the most significant forces to emerge in the first decades of the 21st Century will be the value of human time (and the related issues of quality of life). Burgeoning transportation demand will be dominated by the increasing value of time during the information age, when human/intellectual capital replaces physical capital as the basis for creation of wealth. The new value of time makes doorstep-to-destination speed the premium commodity during this new era. In addition, the next generation consumer will place a higher premium on privacy, security, independence, flexibility, and freedom of choice in products and services, including transportation. Further, the spread of highway gridlock and the expense and limitations of mass transportation solutions exacerbate the emerging transportation demand.
Unique opportunities emerge during these periods of chaos and maturity to exploit technology investments to respond to changing demand. The 21st century transportation demand is shaped by the desire for personal command of schedules and itineraries (mobility and accessibility), higher speed from doorstep-to-destination and greater privacy and security. These desires must be satisfied while maintaining safety, affordability, and convenience for the consumer. In addition, the public requirements for national airspace capacity, efficiency, cost and environmental compatibility of operations must be met. Responsible land use and energy use choices will be enabled by new technology while responding to demand for higher speed transportation (doorstep-to-destination) early in the 21st century.

The ingredients for a significant advancement in transportation are present and will produce the most significant advancement in doorstep-to-destination speed since the emergence of the hub-spoke airways and highways systems is possible. Realization of this advancement will require that the nation meet the challenges of making small aircraft and small airports more accessible to greater numbers of the traveling. Today's small airports represent a national asset that is grossly underutilized. Developing small personal aircraft that can utilize these smaller airports would enable true doorstep-to-destination travel. A currently available set of enabling technologies includes a new generation of engines, avionics, airframe, navigation, communication, and operator training for a new generation of small transportation aircraft. The transportation innovation would take the form of a Small Aircraft Transportation System for personal and business travel. The National General Aviation Roadmap establishes a vision and milestones for SATS integrated within the National Air Transportation System, to contribute to satisfying the transportation demands of the 21st Century". (Holmes 1999)

The implications of such a system to the training community and Air Traffic Control communities are profound. To help plan the program Dr. Holmes has enlisted the help of members of government (NASA, FAA, DOT), industry, and universities. To that end a roadmap has been created to lay out the framework for the SATS program.

Below are some excerpts from the stated goal of the National General Aviation Roadmap

“The National General Aviation Roadmap establishes the framework for coordinated public and private-sector investments toward the goal to "enable doorstep-to-destination travel at four times the speed of highways, to 25% of the nation’s suburban, rural, and remote communities (served by public use airports) in 10 years, and over 90% of those communities in 25 years." The Roadmap provides the framework for public-private sector partnerships that continue to target investments in strategically relevant, enabling technologies. To date, investments have been focused on air vehicle and operator training technologies associated with revitalizing the U.S. General Aviation industry. With completion of the current phase of aircraft technology investments by NASA and industry in 2001, the next step on the Roadmap involves planning investments in infrastructure technologies, along with the next phase of vehicle technologies and their integration. Together, these investments create the basis for SATS.

During the past 5 years, two NASA-led public-private partnerships have been implemented in support of Roadmap Goals: 1) the Advanced General Aviation Transport Experiments (AGATE) Alliance, and 2) the General Aviation Propulsion (GAP) partnerships. By 2001, the GAP and AGATE programs will complete the development of revolutionary advancements in technologies for engines, avionics, airframes, and pilot training. A goal is to enable the development of small aircraft that are superior to automobiles for intercity travel on trips of 150 to 1,000 nautical miles. In addition, FAA and NASA have and continue to invest to enhance safety and to deploy free flight capabilities. The near-term products of these investments include 1). generation of safe, affordable, quiet, and easy-to-use transportation light lanes; and 2. The potential for increased National Airspace System (NAS) capacity by expanding use of existing, underutilized airports and airspace (current NAS infrastructure Classes C, D, E and G), expanding utility of existing general aviation aircraft and demonstrations of SATS aircraft capabilities.

Ultimately, the SATS development might be planned to support a dominant share of the future growth of intercity travel modes for trips of 300 to 500 miles. It is most likely that the increased accessibility to the national air transportation system for a larger portion of the population would have the favorable effect of increasing load factors for the existing hub-spoke system, especially for longer trips of 500 miles and longer.

The SATS concept of operations utilizes small aircraft for personal and business transportation, for point-to-point direct travel between smaller regional, reliever, general aviation and other landing facilities, including heliports. The SATS architecture contemplates landing facilities that would be upgraded to provide near-all-weather utility and would minimize user uncertainty regarding destination services, including intermodal connectivity. The facilities would not necessarily require control towers or radar surveillance. The SATS architecture would operate within the National Airspace System (NAS) infrastructure, between about 5,400 public-use landing facilities. While scheduled air carriers serve only about 660 of these facilities, SATS infrastructure advancements would significantly improve the capabilities at air carrier facilities as well. A total of over 18,000 total landing facilities serve the vast numbers of communities in the U.S; ultimately, virtually all of these facilities could employ SATS operating capabilities.

The SATS aircraft will be predominantly single-engine, single-pilot-operated in near-all-weather
conditions, with a significant fleet of light twin-engine aircraft as well. Notably, the SATS infrastructure requirements for fixed-wing aircraft are compatible with those for rotorcraft. Thus, vertical flight configurations would also comprise a portion of the transportation fleet. The aircraft will incorporate state-of-the-art advancements in avionics, airframes, engines and pilot training and be capable of operating in free flight modes within the evolving NAS. Although the targeted operating environment will be in Classes C, D, E, and G airspace and facilities serving suburban, rural, and remote communities, the aircraft will possess the Required Navigational Performance (RNP) capabilities for operability in Classes A and B airspace. Through intelligent design of the SATS architecture and operating capabilities, the potential exists to greatly exploit the benefits of a faster, distributed air transportation system for rural communities with minimal impact on the capacity of airspace and airports by large aircraft today.

The major elements of the vision are itemized below. These descriptions do not comprise constraints for minimum requirements; rather they are intended to convey the intent of the SATS vision: Infrastructure: "Smart" airports with higher utility and safety in more weather conditions, along with free flight procedures for expanded NAS capacity, and airport utility, including:

- "Highway in the Sky" access in marginal weather to all runway ends and helipads,
- Flight Information Services (FIS), broadcast by terrestrial or satellite systems Traffic Information Services (TIS), including Automatic Dependent Surveillance, broadcast by satellite systems or Commercial Information Services (CIS) for destination information, including intermodal connectivity, and vehicle and operator/passenger services, via terrestrial or satellite systems,
- Near-all-weather, air and ground operations at non-towered airports, without radar surveillance, 3,500 to 5,000 foot runways, helipads, with only necessary marking and lighting,
- Airports within a 15 minute drive of communities served,
- Small aircraft, personally-operated or with hired pilots, serving the dominant personal and business transportation demand spectrum load factors (typically between two to three passengers)
- HITS graphical flight path operating systems, including graphical weather, navigation, traffic, terrain, and airspace depictions, as well as full-featured auto-pilots to relieve pilot workload, enable 4D navigation, and provide backup in times of emergency.
- New quiet engines, burning unleaded fuel, with simplified controls (single-lever power controls), intuitive diagnostics, and longer Time-Between-Overhaul.
- Crashworthy airframes, including airbags and, in some vehicles, whole-aircraft parachutes,
- Speeds of at least 200 to 300 knots for piston and turbine propulsion, respectively.
- Cruise altitudes of 6,000 to 25,000 feet, for the piston and turbine, respectively
- Full-fuel ranges of 800 and 1,200 nautical miles for the piston and

turbine, respectively.

- Aircraft with cost of ownership and operations competitive with automobiles on day trips of 300 miles or more.

Users:

- Simplified and affordable pilot training through advanced technologies, including:
- Consolidated instrument-private pilot training curriculum,
- On-board, embedded training capabilities,
- Training time and cost commensurate with Public School implementation of "Fliers education" along with Drivers education,
- Internet-based, and simulation-enhanced training systems,
- Ability for pilots to maintain all necessary competencies and proficiencies for AGATE Highway in the Sky system flight operations, within constraints imposed by typical professional and personal time schedules". (Holmes 1999)

These are exciting concepts that will require much considerable forethought. In visualizing the training issues, one is forced to hink in new paradigm's, some of them rather alarming. Not only must the public be taught how to use these devices, but other operators in the system must also be considered.

The efficiency and ease of use of SATS depends largely on the development of user friendly interfaces that require a minimum of training, and standardization of basic operational concepts so that operators switching from one mode or aircraft to another have a minimal level of confusion. Discussions surrounding these issues have already taken place.

At a meeting at the NASA Langley Research Center in June 1999, members of the training community along with those from government and industry groups addressed SATS technology and infrastructure issues. Training was clearly identified as a critical element if the SATS concept is to succeed and become reality.

The National Air Space infrastructure is already being revised with the establishment of the architecture for NAS 4.0. Clearly, in order to meet the needs of the SATS environment NAS 4.0 will need additional attention and revision. Issues such as free-flight operations for GA must also be addressed, for while GA currently already operates free-flight in the VFR mode in uncontrolled airspace, much work needs to be done to address its use in terminal and controlled enroute IFR airspace.

The issues surrounding transition from the existing system must also be addressed and minimum equipage requirements considered. AOPA members for example, historically resist the need to purchase additional equipment unless a case can be made that demonstrates a clear benefit to them of its use. Operators will also need to be trained, and while the use of new technology may appeal to the younger generation, it frequently frightens those of us who are older. If we can train the operators, how do we certify that they can operate not only efficiently by safely in the SATS environment? These represent only a few of the issues that must be addressed; more will surely be identified in the coming months and years.

To address SATS "system" issues, a Transport Research Board (TRB) study has been commissioned to examine the suggested system and to make recommendations. However, it is unlikely that the TRB will address training issues, that role will be left to those of us in the training community.

Regardless of whether or not SATS succeeds completely some elements will be successful, particularly those in the technological arena, indeed PFDs and MFDs are already available to those who fly commercial and home built aircraft. HITS displays are currently used by the military and are conceptually possible for the GA pilot (STT). They will become increasingly more available once a commercially available operating system is identified that can be certified. Major issues surrounding the use of these technologies, certification of the device and certification of the pilot remain.

In recognizing the importance and need for SATS, the FAA has developed a "Mission Needs Statement (MNS)". The development of the MNS demonstrates the commitment that the FAA is making to the SATS program. In addition, states with a long commitment to aviation such as Florida, Virginia, and Oklahoma are including SATS needs in their long range planning.

The success of SATS will depend largely on the commitment of government, both federal and state, industry, and universities to the underlying need for a Small Aircraft Transportation System.

The roadmap and full text and definition can be found on the Internet at:

http://sats.nasa.gov

REFERENCES

Holmes, Bruce, Small Aircraft Transportation System Planning Conference, NASA Langley Research Center June 21-24, 1999.

Work Package Six Annual Report, 1998, AGATE Restricted